SOIL CONSERVATION

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VOL. V • NO. 12 ISSUED MONTHLY BY THE SOIL CONSERVATION SERVICE, DEPARTMENT OF AGRICULTURE, WASHINGTON **JUNE • 1940**

ECONOMIC AND SOCIAL CONSIDERATIONS IN FARM PLANNING

By E. H. REED [1]

THE program of the Soil Conservation Service is carried out primarily through complete coordinated plans formulated for individual farms or land units. If these farm or land unit plans are to achieve the purpose of the Service—"to bring about better land use, a better life for people living on the land, and protection of public welfare"—it is evident that they must provide for the most efficient utilization of all resources of the farmer, including the land.

Many ardent advocates of conservation seem to lose sight of the human element, which is so essential in real conservation, and to stress the physical aspects of the conservation problem—in other words to talk of erosion control practices as ends within themselves. There is but little virtue in conserving a tree for the sake of the tree or a hillside merely for the sake of the hillside. As expressed by Secretary Wallace: "Damage to the land is important only because it damages the lives of people and threatens their general welfare. The whole purpose of conservation goes back to that fact. Saving soil and forests and water is not an end in itself; it is only a means to the end of better living and greater security for men and women."

Too frequently people look upon a conservation program as one that holds resources out of use. In its simplest terms, conservation means *use without waste*. It is evident that in assisting farmers in planning farms the job of the Service is much broader than putting land in cold storage for the use of future generations. The real task is to put into effect a plan which over a period of years will best utilize the resources at hand. The farmer is not obtaining the most efficient utilization of his resources if his most important resource, the land, is being rapidly depleted by erosion as a result of improper land use or cropping practices.

Farming is a business upon which the farmer is dependent for his livelihood. The farmer is interested in erosion control practices only insofar as they may help him to conserve his capital and utilize his resources more effectively. Much of the reluctance with which farmers have accepted and applied soil conservation practices has been due to the fact that we have planned farms *for* farmers rather than *with* them, and have talked erosion control practices as ends within themselves rather than means of enabling the farmer to utilize his land, labor and operating capital more efficiently and at the same time conserve the productive capacity of his soil. Therefore, in planning farms with farmers it is important that erosion control practices and land use be considered in the light of the best combination of enterprises required to afford the best utilization of the resources of the farm and farmer.

Erosion control is achieved through a combination of proper land use and proper practices. Neither proper land use nor desirable practices can be determined on the basis of physical data alone but must be determined through a consideration of physical capabilities plus economic factors. Land-use capability classes do not determine land use but merely portray the capabilities of the land. The managerial

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Recommendations for Land Use, Cropping Systems and Supporting Practices for Land-Use Capability Classes

Land-use capability class	Land Use	Cropping systems	Supporting conservation practices	Soil treatments
I (Green)	Cultivation	Row crop 2 years, small grain, hay	None	Manure
II (Yellow)	Cultivation	Row crop, small grain, hay	Contour stripe, 75'-125', or terraces	Lime Manure
		Row crop, small grain, hay 3 years	Contour cultivation	Lime Manure
		Row crop, small grain, hay 4 years	None	Lime Manure
	Pasture	None	None	Lime Manure
III (Red)	Cultivation	Row crop, small grain, hay	Contour strips and terraces	Lim Ma
		Row crop, small grain, hay 2 years	Contour strips 60' - 100'	
		Row crop, small grain, hay 4 years	Contour cult	
	Pasture	None		
IV (Blue)	Pasture	None		
	Woodland			

ability and likes and dislikes of the farmer, his available labor and operating capital such as machinery and livestock, must be considered in relation to the capabilities of the land.

A number of methods might be used in controlling erosion on a given sloping field. For example, it might be devoted (*a*) to pasture, (*b*) to meadow, (*c*) to a long rotation with several years of hay, (*d*) to a rotation of medium length with contour cultivation and buffer strips, or (*e*) to a short rotation with terracing and strip cropping. Any one of these uses might satisfactorily conserve the productive capacity of the field. The use to which a particular field should be put will depend primarily upon economic factors. If the farmer needs pasture, and other fields on the farm are better suited for clean-tilled crops, he should probably put this field to pasture. If, on the other hand, he cannot utilize the pasture, he might terrace and strip crop it and use a short rotation. Economic factors should thus be considered in selecting the land use, the rotations and the practices which he should use.

Alternative combinations of land use and practices are not inconsistent with the definition of land-use capability classes. Land-use capability classes indicate the most intensive use of land and the least intensive conservation practices consistent with permanent maintenance of the soil. They are based largely on physical characteristics. It is not inconsistent to use class II land for class IV purposes if such use will better fit the needs of the farmer. As shown in the accompanying table there are several alternatives of land use, rotations, and supporting practices under each capability class. For example, class II land might be used in a 3-year rotation if strip cropped or terraced, or could be used in a 6-year rotation with 4 years of hay without supporting practices.

Many planning technicians realize that economic factors should be considered in planning, but they are at a loss to know what information is needed or how best to consider this along with physical information. It is therefore important that further attention be given this subject. No rule-of-thumb guide can be given that is applicable under all conditions, since each farm is an individual problem. However, certain steps, as outlined below, have been proved by experience to be desirable.

Inventory

An inventory of both the physical and economic conditions on the farm is necessary. The *physical inventory* consists of a determination of soil type, slope and erosion of the various fields on the farm. In order to make this information fully intelligible and useful, these factors should be expressed in land-use capabilities.

The *economic inventory* should consist of a record of the present organization of the farm such as acreage, production, and utilization of the various crops grown on the farm, together with the kinds and numbers of livestock produced. The approximate amount of labor and operating capital available for the operation of the farm should also be obtained. If the farmer is cooperating with the A. A. A., information should be obtained relative to the acreage allotment of the various crops. Insofar as practicable, these acreages should then be provided for in the farm plan. Under some conditions, additional information may be desirable; for example, the ownership or tenure status, the amount, source, and cost of irrigation water or other information of like nature that should be considered in the formulation of the new plan for the farm.

While obtaining this information from the farmer, the farm planner should obtain a concept relative to the farmer's knowledge of and interest in conservation; his knowledge of the principles that determine land use, and his knowledge of the applicability of various erosion control practices. The farmer's managerial ability and his knowledge of various enterprises, together with his likes and dislikes, should be considered

It would also be well to obtain, without making any commitments, the farmer's opinion as to the desirable changes which should be made in the farm organization in light of erosion control.

Determination of Alternatives

After the farm planner has obtained a clear-cut inventory of both physical and economic conditions, he should then determine in the light of this information the various alternatives in organization of the farm or combinations of enterprises which might be used in the best utilization of the resources of the farm and the farmer. It should be understood that "best utilization" includes conservation. It should be kept in mind likewise that resources of the farm and farmer include labor, operating capital, managerial ability and likes and dislikes of the farmer, as well as his land.

If it is apparent, on the basis of information obtained from the physical inventory, that comparatively little change is needed in land use, and that the major changes required would be the institution of erosion control practices such as terracing and strip cropping, the problem of organization may be comparatively simple. Even under this condition, however, careful study should be given to determine what if any effect the institution of such erosion control practices will have on the present organization or operation of the farm. For instance, one of the desired practices might be a change in rotation with a decrease in the acreage devoted annually to clean-tilled crops, and an increase in close-growing crops. If this were a livestock farm, such a change in the rotation would probably throw the feeds for livestock off balance. If little or no livestock is kept and the crops are marketed directly as cash crops, the question then arises as to the market outlets for these close-growing crops and the possibilities of income under the proposed plan as compared with the original plan.

In case it is apparent on the basis of physical information that considerable changes are needed in land use as well as practices, the farm planner should select a combination of land use and practices that would be satisfactory from the standpoint of soil conservation. He should then calculate the physical quantities of products which, on the basis of expected yields for the farm would be available under this assumed organization and combination of enterprises. For example: What quantity and kinds of cash crops would be available for sale? How much feed would be available for livestock? Are the various kinds of feed (grain, hay, and pasture) in proper proportion to livestock feed needs? Under this organization, will the farmer be able to keep more or less livestock than formerly? What effect would such an organization have on the labor or operating capital requirements? Can the farmer meet these requirements?

The farm planner should then select another combination of land use and practices, in order to test the desirability of the second alternative as compared with the first. The same process of thinking and calculation as suggested above should be pursued in each new combination.

In complicated or difficult situations, or until the farm planner obtains considerable skill in selecting alternatives, it may be necessary to assume a third, fourth, or even fifth alternative and calculate the probable results as outlined above so that he may be able to discuss intelligently with the farmer the relative desirability of the several alternatives. The farm planner in some instances may desire to do this figuring in the presence of and in consultation with the farmer; often, however, he may prefer to make these calculations in the office and use them for discussion with the farmer at a later date. If the farmer has attended a number of group planning meetings he may be able to suggest the various alternatives for consideration with the farm planner.

Selection of the "Best" Alternatives

After these several alternatives have been considered by the planning technician, he is then in position to consider them in cooperation with the farmer and to select, after thorough discussion with the farmer, the alternative which in their combined judgment will best conserve the physical resources of the farm and at the same time provide for the most efficient utilization of the resources of the farm and the farmer. Through a discussion of the advantages and disadvantages of the various alternatives, the farmer should understand why the selected alternative is "best" and what if any adjustments will be required in his present system of farming or practices. For example, in order to utilize efficiently any additional hay, is it desirable to increase roughage-consuming livestock or shift from cash crops to a combination of cash crops and livestock? Does he need to change his feeding practices? Does he have sufficient barn room to house the additional livestock? If this process of thinking

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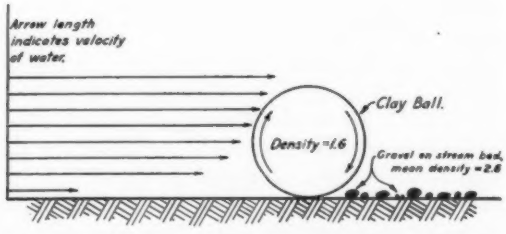
THE "WHEELS" OF EROSION

By HUGH STEVENS BELL [1]

IN the January 1940 issue of SOIL CONSERVATION Dr. Mark L. Nichols states that the whole field of the hydraulics of erosion is practically untouched and lists many of the unexplored problems involved. Among these he mentions the transportation of erosional debris as bedload. Field and laboratory studies of one of the most efficient methods of bedload movement were completed recently at the Cooperative Laboratory of the Soil Conservation Service and California Institute of Technology at Pasadena, Calif. These particular studies developed as a byproduct of assistance given to technicians of the Las Posas project at Santa Paula, Calif., during an investigation of gully development which was in progress at the time of the spectacular storm of February 27–March 2, 1938. A more detailed and technical discussion of the material presented in the present paper has been published in the Journal of Geology.[2]

More than a quarter of a century ago G. K. Gilbert [3] pointed out that particles are transported by a stream in four ways, depending on their size, shape, and density. They may slide, leap, roll, or be carried in complete suspension. Only the first three of these methods are available for the movement of bedload, and they are listed in the ascending order of their efficiency. In other words, a bedload particle that is round enough to roll will travel more swiftly than those of equal weight and density that are forced by their shapes to slide or leap.

It is widely recognized that the wheel is man's greatest invention, but it is practically unknown that Nature sometimes uses wheels to roll erosional debris away, and thus greatly accelerates the cutting of gullies in areas where clay is abundant. Balls of clay or mud are just such wheels, and many streams are able to produce them rapidly in enormous numbers during times of flood. The accompanying photographs show some scattered over the surface, and others forming an important part of the bed deposits about a mile downstream from the mouth of a gully in Ventura County, Calif.



Why a clay ball is transported more rapidly than the smaller units of a bedload. Increased efficiency results from a combination of high velocity, low density, and great sphericity. Invariably, such balls are large in comparison with the particles which form the stable bed of the stream in which they are formed.

Ordinarily such balls are looked upon as mere curiosities—freaks of nature. Actually they are among the most efficient and effective devices to be found in the entire erosion set-up. A rough, angular block of clay caves from the bank or is torn from the bottom of a stream. If it is not too large it is immediately swept along by the flood and its numerous sharp angles are rapidly abraded or molded into roundness. If it strikes some fixed object squarely it may be broken into many pieces, but the individual fragments often are rounded into shape quickly by continued tumbling and pounding.

Within as little as 10 minutes the original irregular block may become one or many clay cobbles or boulders which leap from the bottom with decreasing frequency as they become increasingly spherical. Pebbles, shells, bits of broken glass, rusty nails—hard and heavy objects of every description—adhere to the sticky, softening clay mass, and are driven more deeply into its plastic outer layer with every revolution, every leap of the rapidly forming ball.

Such heavy particles are the very ones which a stream must depend upon to stabilize its bed, but the clay balls may actually remove them so thoroughly from the bottom that the rushing waters cut rapidly into the underlying softer materials.

An hour after a clay chunk starts its journey it may have become as round as a ball, and have traveled 3 miles, meanwhile collecting nearly 50 percent of its original weight in gravel and other foreign material as it rolled. All this may have happened, and the ball is

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[2] Armored Mud Balls—Their Origin, Properties, and Role in Sedimentation. By Hugh Stevens Bell. Journal of Geology, Jan.–Feb. 1940, pp. 1–32.

[3] The Transportation of Debris by Running Water. By G. K. Gilbert. U. S. Geological Survey Prof. Paper 86, 1914, p. 200.

deposited in a permanent resting place before it has been wet to a depth of more than an inch. Estimates, which are thought to be conservative, show how important this method of bedload movement sometimes becomes, for they indicate that approximately 500 tons of clay and over 200 tons of gravel were removed from one Ventura County gully in this way during a single flood. A more striking example occurred some 20 years ago, when Corn Creek, a tributary of the Little Colorado River, built a dam of mud balls across the main stream and forced it to abandon a section of its channel permanently.

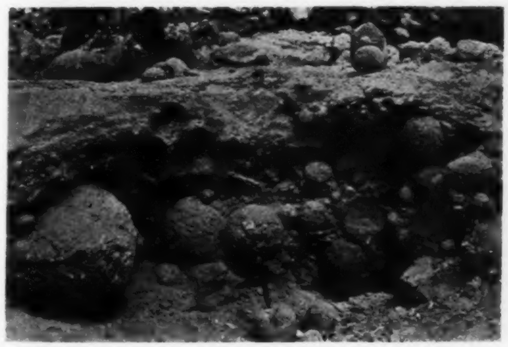
The size of the pebbles which may be transported by mud balls is directly proportional to that of the balls themselves. Stream-made balls commonly vary in size from slightly less than 1 inch to about 1 foot in diameter, while the maximum size of the particles they carry ranges from that of peas to that of hen's eggs.

A clay ball may have a density of 1.6 and the pebbles on the streambed a mean density of 2.6. Since a stream can transport spherical masses of a light material more readily than it can the irregular fragments of a much denser substance, it is obvious that any pebble which becomes attached to a mud ball can be more easily moved by the stream because it has, in effect, decreased its density by becoming a part of a less dense whole. Since the clay mass is comparatively large the pebble greatly increases its effective size and, in all probability, its effective sphericity as well.

Each of these changes makes it possible for the stream to transport the pebble more swiftly and more easily. Being effectively lighter and rounder it not only can be rolled with comparative ease, but also its greatly increased effective size subjects it to much higher velocities, as the diagram indicates. This is of great importance, because the weight of a particle which may be moved increases as some power of the velocity. If the widely discussed sixth power law is valid, then an increase in velocity of 2, 3, or 4 times allows the weight of the particle that can be transported to be increased correspondingly 64-, 729-, or 4,096-fold. Thus it is seen that with the aid of mud balls a stream is able to put its higher velocities to work and, with both efficiency and power greatly increased, move enormous quantities of those smaller, denser particles that ordinarily remain to hinder erosive processes.

It is no longer possible to look upon mud balls merely as interesting curiosities. Surely any device which makes it possible for a comparatively small quantity of

Hundreds of mud balls abandoned by the receding waters of a California flood are shown in the photograph above. The picture below was taken about five months later at the same location. It shows that the balls were present in great numbers beneath the surface, where they played the role of ordinary cobbles and boulders in the channel deposits.



water to move a million pounds of clay and 200 tons of gravel from one gully during a single flood, and transport that material with efficient dispatch to a point miles away, ceases to be only an object for the amusement of the curious.

Long after ordinary bedload particles have ceased to move and the heavier units of the suspended load have been dropped by the stream, the mud balls roll persistently onward, gathering and carrying with minimum effort a burden of those pebbles which, because of their irregular shapes and greater densities, soon would have been abandoned by the stream or perhaps never moved at all. Though the waters of the gully debouch upon an alluvial fan and spread wide in a dozen distributaries, still these wheels of erosion move quite steadily forward and, if the bed be smooth and firm, refuse to stop even when the water is no longer deep enough to cover them completely. When at last

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THE ROLE OF NEEDLE-AND-THREAD GRASS IN THE GREAT PLAINS

By B. W. ALLRED [1]

THE purpose of this article is neither to minimize the vices of needle-and-thread grass (*Stipa comata*)—hereafter referred to as needlegrass—nor to proclaim its virtues. It is to give instead a general picture of its ecological position and economic significance on the range lands of the Great Plains.

Probably no other grass in the Great Plains is in such bad repute as needlegrass. Resentment is keenest during the fruiting season when the sharp barbs of the fruit, commonly called the seed, spear anything coming in contact with them. Where dense stands occur, they are nearly as formidable at seeding time as a cactus bower. Fortunately, the seed-maturing period lasts only 2 or 3 weeks during early summer; after this the seeds drop to the ground where they remain, quite inoffensive. The plant is generally condemned by stockmen, but sheepmen have the most serious case against it. The seeds with their long awns make a fleece look like a pincushion and the sharp barbs often pierce the eyes of sheep and blind them. The barbs also work through the wool into the skin, starting irritations that sometimes cause a sheep to shed its fleece.

Accurate statistics on actual damages resulting from this plant are lacking, but my experience with sheep in southern Colorado and Wyoming does not bear out some apparently exaggerated claims of heavy sheep losses. I have never seen more than 12 sheep among bands of 1,000 head that suffered blindness or broken fleeces from the ill effects of the grass. It is claimed by some sheepmen, however, that buyers impose rigid cuts against lambs suffering injuries from needlegrass. The barbs may also cause distress to grazing animals even when no economical loss is apparent. In certain localities stockmen have been induced to start work to obliterate needlegrass, but such a task, if carried through, would bankrupt the monetary resources of the Plains without accomplishing its purpose.

The acute interest in needlegrass has prompted many inquiries as to the origin of the species. Many believe that it is an immigrant from another region that has become naturalized here since the great drought of 1934. One of my purposes in writing this article is to attempt to show that needlegrass is a true native of the Great Plains. This grass has one of the most clean-cut genealogies known to plant science, and fossil specimens show that it has inhabited the Great Plains since the Tertiary (Oligocene) geological epoch, which by some geologists is dated back about 35 million years. The study of ancient specimens has thrown considerable light on the vegetation, climate, and habitat of that epoch. Photographs of age-old needlegrass (*Stipa kansasensis*), made by Maxim K. Elias, paleobotanist at the University of Nebraska, in 1931, indicate a striking similarity to the present needlegrass of out Great Plains. Elias and others found, in the deposits with the ancient needlegrass, other plant associates such as hackberry (*Celtis willistonii*) and stickseed (*Krynitzkia coroniformis*). Likewise, these fossils show a remarkable resemblance to the common hackberry (*Celtis communis*) and stickseed (*Krynitzkia* sp.) of the Great Plains. These studies have given background for the belief that the climate of that remote age was semiarid, though probably less so than now.

Needle-and-thread grass (**Stipa comata**) *in its native habitat northwest of Rosebud, S. Dak.*

Elias (1935) states that these plant remains were collected also in the unsorted continental deposits of early Pliocene age where they were associated with the fossil bones of *Pliohippus leidianus*, the Pliocene ancestor of our modern horse. It is believed that the Pliocene geological formation represented the flood plain habitat of the Rocky Mountains piedmont. The undisturbed condition of the plants indicates that they were buried close to their place of growth.

Clements (1936) states: "It is probable that the evolution of grassland proceeded more rapidly in the

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period of mountain-making in the Upper Oligocene to produce the forerunner of the modern prairie in the Miocene, where the typical genus Stipa is recorded, along with horses of the grazing type, *Merrychippus* and *Protohippus*."

The study of paleobotany has established the residential status of needlegrass so far as antiquity is concerned, and ecologists such as Pound and Clements (1898), Weaver and Clements (1929), Hanson and Whitman (1938), and Shantz (1938) have recognized it as a climatic dominant over wide areas of the Great Plains. Range forage investigations made by the Soil Conservation Service, since 1935, show its presence in the semiarid range lands of Montana, the Dakotas, Wyoming, and Nebraska. They have reported it to a more limited extent in eastern Colorado, and more prominently again along the Rocky Mountain front in Colorado to as far south as central New Mexico. It is known to extend throughout the semiarid plains of Canada to the hardwood forest belt in the north.

It is rarely found in pure stands in large areas, although it is not uncommon to find small communities of it comparatively free from other associates. It is most commonly found growing with blue grama (*Bouteloua gracilis*), nigger wool (*Carex filifolia*), and western wheatgrass (*Agropyron smithii*). During years of abundant spring rainfall it dominates the scene, for it is of northern derivation and springs forth early to mature and disseminate its seed before midsummer, ahead of the customary dry summer weather. In the seasons when spring rains are deficient and summer rains of greater abundance, the needlegrass is superseded in prominence by later growing grasses such as blue grama. This situation no doubt accounts for the opinion held by some that the plant was nonexistent on the Plains during the drought but appeared as if by magic once the drought subsided and spring rains reoccurred.

When considered as a forage for livestock, needlegrass ranks about 25 percent below blue grama, nigger wool, and western wheatgrass. Were it not for its pernicious seeding habit it would be rated very favorably by stockmen. In any event, it plays a significant role in the economy of the range land. Because of its early spring growth habits, like that of prairie junegrass, western wheatgrass, and nigger wool, also of northern origin, it furnishes timely early green feed to lambing ewes and calving cows in need of succulent grazing for milk production. The grass is relished by livestock until the time of seed maturity, after which it is rejected for the tender summer-growing grasses such as blue grama and buffalo grass (*Buchloë dactyloides*). During years of late rainy autumns, needlegrass greens up and remains so until snow falls. Its dry leaves and stalks are a desirable source of winter feed for cattle and sheep, particularly during times of deep snowfall when the short grama and buffalo grasses are covered. Native hay produced from it compares favorably with western wheatgrass hay as a maintenance ration, if it is cut when the seed is in the early dough stage. If allowed to mature before cutting, the hay will be full of barbed seeds and unsuitable for feeding purposes.

When it is in its undisturbed natural habitat, needlegrass usually prefers the better drained medium-textured or gravelly outwashed soils. It tends to give ground to western wheatgrass in the better-watered lowlands and swales. It gives way in the same manner to the short grasses on the more arid upland sites, and in turn during the dry years it moves into the draws and swales with western wheatgrass and in wetter years invades the short grasses in the more arid spots. However, it is equipped to perform the functions of a "crisis" plant and can readily take over disturbed areas of either sands or heavy clays, unless kept down by excessive alkali or active blow dirt. It can perform this role quickly as it has special equipment for migrating into barren areas and populating them until other less mobile species can follow. By means of a barbed seed shaft, it attaches itself to livestock, rodent, or man, and is carried to new areas. It has an adaptive device known as a hygroscopic awn, a threadlike appendage attached to the seed that draws up like the spring on a clothespin during dry weather and uncurls during wet weather. When the awn is coiled, a stiff wind can blow the seed for short distances. After the sharp barb settles on the ground it works into the soil by means of the movement of the awn, very much as does a porcupine quill into living flesh. As the barbed seed works into the moistened topsoil, it softens and the seed goes to rest in a soil medium suitable for late fall or early spring germination. The ingenious seeding devices just described give needlegrass a decided advantage over most other plants in invading and establishing itself on new sites.

This grass is not being used by the various Federal agencies in their reseeding programs because of its barbed seed; efforts to find a practical way of detaching the awns so that the seed can be seeded through drills have been unsuccessful. The awns likewise make

hand seeding impracticable. However, there is no need to seed this grass artificially for the purpose of regenerating abandoned farm lands or depleted range lands, because western wheatgrass takes over abandoned land as easily or more easily than needlegrass. Wheatgrass can be sown through a drill; it yields more seed; it has a little higher feed value and has none of the undesirable qualities of needlegrass. Crested wheatgrass (*Agropyron cristatum*), western wheatgrass and grasses not native to the Plains can be used in place of needlegrass for artificial reseeding on abandoned farm lands and are in fact superior to needlegrass.

Needlegrass is found most abundantly on well-managed range lands or on areas long under protection from livestock, and sometimes on abandoned lands returning naturally to perennial vegetation. This is further borne out in studies by the Soil Conservation Service on Indian Reservations in the Plains, relict areas in South Dakota, and protected ranges in Montana, Wyoming, and North Dakota.

Like other mid grasses (or tall grasses), needlegrass is handicapped by unrestricted grazing, to the benefit of such shorter species as grama, nigger wool, and buffalo grass. Continued close cropping of needlegrass by livestock during its growing season reduces the green leaf and stem surface needed to build up the essential food reserves. Successive abuses of this kind are responsible for depletion of many of the forage plants on the range. The reduction of needlegrass in the Great Plains has been verified by Weaver and Clements (1929) and by Sarvis (1923), who found that the plant lost dominance as a result of heavy grazing in dry years. It is further borne out by the studies of the Soil Conservation Service on relict areas in South Dakota and the golf course at Rapid City, S. Dak., as well as on comparative study on used and unused range land near Baker, Mont.

The fact that moderate use to overuse of range lands brings a reduction in needlegrass in the Great Plains will invoke no lament from stockmen. But it is significant to know that when this grass is removed by overuse, on ranges where it is a natural member of the original plant association, the forage resource is probably reaching the critical point from which deterioration may quickly set in. On these ranges needlegrass can be used as a delicate barometer, as its recession is the first indicator of range deterioration. The next stage of recession will be noted by the presence of indicator plants of poor feed value such as snakeweed (*Gutierrezia sarothrae*), silver sage (*Artemisia frigida*), sagebrush (*Artemisia tridentata* and *A. cana*), and perennial aster (*Aster multiflorus*), in the earlier stages of deterioration; and such plants as annual sunflowers (*Helianthus annuus* and *H. petiolaris*), Russian thistle (*Salsola pestifer*), pigweed (*Amaranthus retroflexus*), gumweed (*Grindelia squarrosa*) and many others in the later stages. These plants have low feed value and produce inferior parts for the purpose of soil protection.

Needlegrass has inhabited the plains for geologic ages and even though it has undesirable qualities during its seeding season, a better understanding of its habits and qualities will facilitate dealing with it and may in some instances actually point the way to advantageous use of the plant. Needlegrass is pestiferous to all stock during its seeding period and is particularly irritating to sheep. However, the task of lessening the livestock losses from this source may not be so difficult as is presumed. The only sheep that need be subjected to it are those that summer in the plains.

There are millions of acres of abandoned farm lands in the Great Plains, yielding nothing but annual weeds, which could be converted to perennial grasslands to supply feed during critical periods. These areas might well be seeded to grass both to provide pasture for use when needlegrass is bothersome on the native range, and to provide early spring and late fall grazing.

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IMPROVED TILLAGE AND RESIDUE MANAGEMENT PRACTICES IN REGION 9

By SAM L. SLOAN [1]

ONE of the first recommendations of the Soil Conservation Service in Region 9 (Washington, Oregon, and Idaho), when an operations program was undertaken, was that the burning of stubble be stopped and all crop residues be utilized for erosion control. The practices involved in this recommendation have more significance and are more effective in the control of erosion on farmlands in these three States than in many other general farming areas.

In the first place, most of the agricultural land in the Wheat Belt is farmed in large units under a one-crop, alternate fallow-and-wheat system necessitating heavy machinery. This situation limits the scope of practices that may be applied in a diversified farming system with smaller farms and smaller equipment; it also gives greater significance to those practices that are applicable and effective without the introduction of major adjustments.

Secondly, because of the winter type of rainfall common to the region the heaviest soil and moisture losses occur in late winter and early spring. The limited cover afforded by fall-sown grain constitutes another factor necessitating greatest possible use of crop residues in such a way that they are effective not only during the summer fallow season but also through the critical erosion period in the spring. Fortunately, crop residues are abundant over most of the wheat-growing area; thus it is possible, with proper management, to limit soil and moisture losses from cultivated lands by using a combination of tillage practices.

We can better appreciate the importance of the problem when we consider that it has been common practice over much of the wheat-growing area of the region, since wheat growing was started, to burn part or all of the stubble. If any remained it was turned down completely in the first tillage operation. A radical change from this custom is observed, however, in the adoption and application of a series of delicately adjusted operations providing for conservation and use of residues in quantity sufficient for erosion control.

Data from evaluation studies conducted at the Wildhorse project in eastern Oregon, during 1937 and 1938, show that about 300 pounds of straw per acre, left on the surface at fall seeding time, serves to reduce soil and water loss effectively; and that an adequate mulch of stubble on the surface in combination with contour seeding, provides a high degree of erosion control in normal years. Data from evaluation studies in the Palouse indicate that to control erosion at least 500 pounds of straw, or more, depending on slope gradient, must be left on the surface in the fall. A research program has been initiated, in cooperation with State agencies in both Idaho and Washington, to obtain reliable data on the role of crop residues under a variety of systems of management, in the control of erosion and interrelated effects on crop yields, soil moisture, available nitrogen, soil temperature, soil structure, etc.

The use of crop residues for wind-erosion control is an established practice in many communities throughout the region. Abandonment of large areas has been forestalled and other areas actually have been reclaimed by careful husbanding of all residues and by fallow operations conducted in such a manner as to obtain maximum protection against the destructive forces of wind erosion.

Three distinct conditions are encountered in various sections of the region. The first is found in the area where annual cropping is practiced (e. g., wheat and peas), with large yields of grain the rule and correspondingly heavy crop residues. Another condition exists in the better wheat-growing sections of the summer fallow area where precipitation is insufficient for annual cropping but is more than the minimum required for dry farming. These sections produce uniformly high yields, with heavy crop residues. The third condition is that found in areas of low rainfall where the precipitation is slightly above the absolute minimum for wheat growing, and here are moderate to low yields and light crop residues. Seasonal variations within any of these areas influence the amount of crop residues to be dealt with and determine the type and number of operations required to utilize the crop residues properly.

The first problem was to overcome the objections, the difficulties, and the negative attitude of cooperators in handling crop residues according to recommendations. This involved determining for each situation

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A satisfactory job of residue management. End of fallow period shows straw and clods on the surface, lower portion of tilled zone compacted. The seedbed is in good condition for fall wheat.

the type of implement best suited to the work, or the modification that could be made in available implements to accomplish desired results.

Early crop-residue management practices stressed mixing the residues with the furrow slice. Although this practice is not objectionable under certain conditions of rainfall and a high level of available nitrogen, a lack of this balanced soil condition is almost certain to result in lower yields than if the stubble were burned or turned down with a moldboard plow.

Observations and limited experimental data have revealed that increased protection from erosion is obtained, and that there is less effect on crop yield through disturbance of the carbon-nitrogen ratio, when the crop residues are placed largely on the surface instead of being mixed with the soil. Because of this, efforts in the residue management program have been directed toward the maintenance of a "straw mulch" on the surface rather than toward a stressing of the "trashy fallow" method.

Notable results have been obtained in standardization of the technique of management and in bringing about an appreciation of the importance of proper residue management on the part of cooperators and farm leaders throughout the wheat-growing area of the region. The principles involved in proper residue management must be understood by the operator, as the specific operations, their number and sequence, are determined by the amount of residue available for utilization, and its condition especially at the time of the first field operation. One of the first of these principles to have wide application in the region is that embodying the idea that more effective erosion control is obtained after the fallow period by leaving stubble undisturbed in the fall than by fall tillage.

In the management of very heavy crop residues, especially in preparation for a spring crop, it is necessary to perform one operation in the fall with the disk or one-way to induce partial decomposition and to reduce the amount of residue to a point permitting satisfactory handling in future operations. In other areas that receive heavy snow, particularly where heavy soils or tight subsoils are found, and in areas subject to rapid snow melt and run-off when the ground is frozen, fall chiseling on the contour is necessary.

The most commonly recommended procedure, however, is that stubble be left standing over winter. Use of a modified moldboard plow, lister bottom, or one-way is followed promptly by the rotary rod weeder to compact the lower portion of the disturbed area to prevent evaporation. Necessary rod weeding operations follow as required for weed control. The modified moldboard plow or lister bottom is used for the plowing operation because with this type of implement the soil is loosened from below with a minimum of turning action and the crop residues are left mostly on the surface. A point in favor of these implements, and one that has influenced their acceptance,

is that they till the soil to the normal depth and leave the straw on the surface. Substantially the same results can be obtained with the one-way if it is run at the proper speed; the speed determines to a large degree the amount of coverage of the residues. The one-way also is successful in excessively trashy and weedy fields where other types of implements will not handle the residues. Regardless of the care exercised in using this implement, however, it does have a pulverizing action that destroys the structure of the soil in most soil types.

The change from black fallow to complete or even partial stubble utilization necessitates a change in the type of drilling equipment. Although the double disk drill is used extensively, the single disk drill is most commonly recommended, as it will cut through a greater amount of trash. The deep furrow drill is adapted in areas subject to wind erosion. This type of drill will operate in heavy residue and provides added wind-erosion control where crop residues are light.

The areas of low rainfall and light residues present no special difficulties in the residue management program except in seasons of abnormally high precipitation. Supplemental control sometimes is necessary during years of exceptionally light cover, and this usually is accomplished by contour strip chiseling or even solid chiseling, especially in heavy soil areas or where quick snow melt occurs while the ground is frozen. Basin listing may be applicable under these conditions, although the field of application is limited definitely to long slopes of low gradient.

The common practice under average conditions is to leave the stubble over winter, to plow in the spring with a modified moldboard plow or similar implement, and to follow with a rod weeder for weed control, limiting the number of operations to the absolute minimum. The rod weeder is the most adaptable and widely used weeding implement in the region; it has replaced the stationary rod and blade weeders because it will cultivate fallow with a heavy trash cover. It is also replacing the one-way for weeding operations because it leaves a more trashy, cloddy surface. The duckfoot is little used except for noxious weed control, the principal objection being that it is difficult to control on steep slopes and that the ridges and furrows left are bound to accelerate erosion except on moderate slopes where contour operation is possible. Modification of the ordinary duckfoot shovel in the form of a flat sweep, to accomplish subsurface tillage without ridging, is a promising development.

In seasons of extra heavy yields of residue, the operator must deviate from his usual practices and follow about the same schedule as outlined for the more humid areas. This will involve one fall operation with a disk or similar implement. In performing this operation, it is, or should be understood by the operator that any treatment of the straw after harvest will result in a decrease in the amount of crop residues.

In areas of heavy snowfall and drifting, uneven distribution and loss of moisture are highly probable if the standing stubble is disturbed. As to speeding up or retarding percolation of moisture, this fall operation may work both ways, depending on the physical condition and type of soil. If only the length of straw, not the weight, is the problem, it may be handled by spring disking to cut the straw in shorter lengths and thus prevent clogging of implements used for subsequent operations. The fact that plowing is not necessarily the first operation in the management of grain stubble is gaining recognition. Preparing the stubble for the plow or other initial tillage implement, so as to facilitate proper residue management, is becoming an established practice in many areas.

Having the straw spreader attached to the combine is the first step in residue management under all conditions. In areas where preservation of all available residue is as important for erosion control as it is in the areas of limited rainfall, the distribution and placement of the residue, through the use of the straw spreader, is of primary importance. Although the collection of chaff in dumps for use as stock feed is permissible, the bunching of the straw or failure to use the straw scatterer usually results in poor utilization.

Pasturing of stubble and crop aftermath is a common practice in semiarid wheat-growing areas. Where stubble grazing is practiced, however, unless definite control of grazing is enforced the erosion loss frequently is greatly in excess of the value of the pasturage obtained; and, because of the extreme seasonal variation, both in yield and in palatability of the aftermath, it is practically impossible to establish a standard of permissible intensity of use.

The development of a number of new implements is facilitating the program of tillage and residue management. To receive consideration, however, every new development must follow the principles and procedures described above, if it is to prove of practical use in the management of crop residues for erosion control.

Glimpses of the C.C.C. at wor

Wire and brush dams facilitate gully control work.

Fences on the contour are vital features of the new farm programs.

C.C.C.–S.C.S. camps a t in ma the er to f

on the land

Broad-based terraces are valuable in erosion control on sloping lands.

...mps as... in maintenance of drainage ditches to allow the ...ter to flow freely to outlets.

Overflow pipe outlets from dams must be carefully laid to grade.

SOIL CONSERVATION STRENGTHENS CREDIT RATINGS

By A. G. BLACK [1]

FIFTY million dollars' worth of farm loan security washed or blown away each year—such is the estimated annual damage by erosion to farms on which the Federal land banks and the Land Bank Commissioner have mortgage loans.

Constant erosion by wind and water demands the attention of nearly every farmer who is trying to pay for his farm or add to his income by the use of credit. To this end our farm credit institutions are working with the Soil Conservation Service and other agencies of the Department of Agriculture to build and save soil.

Thousands of farmers with Federal land bank and Land Bank Commissioner loans are participating in soil conservation programs. Officials of the national farm loan associations and production credit associations are helping to arrange contacts between their members and the local soil conservation staffs. Soil conservation work is also being carried out on farms owned by the Federal land banks. All of our cooperative credit institutions can do much to encourage complete farm conservation plans including combinations of practices and measures for the control of soil erosion—field rearrangements, contour farming, terracing, grass and legume seedings, dams, and tree planting.

When a farmer makes a mortgage he assumes a risk. If the mortgage is on a farm subject to erosion he assumes a double risk. Several years ago one of the Federal land banks made a study of the relation between soils and credit. The bank found that the farmer on a "good-soil" farm usually pays out of debt. Where the soil is thin or badly eroded he is more often foreclosed and sold out. No group of farmers can lose more through soil erosion than those who are in debt. No group can benefit more through soil conservation.

The soil auger of the farm land appraiser has told the story many times. Five or six years ago appraisers for the Farm Credit Administration used soil augers in appraising nearly a million American farms. That was during the emergency program to refinance farm debts. What those soil augers showed about farm values was as important as the long-range prospect for prices of corn or cotton. Several hundred thousand applications were rejected. Soil erosion was more responsible for these rejections than any other one factor.

No indebted farmer, and no creditor institution can long afford to overlook the damage which erosion is constantly causing. Wind and water have no respect for prior liens. Some types of erosion are not visible to the untrained eye. Sometimes a farm loan breaks down before the real cause is discovered. Too much emphasis cannot be given to the need for close cooperation between the land banks and agencies of the Department that are administering programs to help farmers save soil and water.

More than a dozen years ago the Federal land bank of Houston became alarmed by the declining yields of cotton in the black-soil area of Texas. People had thought the soil of this area was inexhaustible. But declining farm income, difficulties in repaying loans, discouragement of farmers—all these factors pointed to the insidious effect of soil erosion and soil depletion. The Federal land bank and the Extension Service could do little more than make a start in aiding the owners of this land to check soil erosion and build up soil fertility. With the help of the Soil Conservation Service, farmers in one section of the Texas Black Belt have recently established the largest contiguous area of conservation-treated land in the United States. Here and in many other soil conservation districts throughout the country, farmers have a basis for credit, and a repayment ability, which they did not have before. The same comes from the assistance given by the A. A. A. program in saving the soil. All this conservation work has improved soil ratings. It has also improved credit ratings.

Soil conservation helps to stimulate good farming practices. It tends to cut down one-crop farming; it encourages diversification, such as cover crops, grazing, and livestock. Conservation has an effect on soils. It has an effect on people; the increased pride of ownership that comes from a well-kept farm is almost as important as the dollars and cents. This is another reason for believing that soil conservation will pay the indebted farmer a double dividend for his efforts.

(Continued on p. 308)

[1] Governor, Farm Credit Administration, Washington, D. C.

Millet stubble (left foreground) and millet stalks (center foreground) trace the line where mowing was stopped. The block of soil is about 700 feet from its original position. Part of the eroded area is discernible at the left.

OBSERVATIONS ON A FLOTATION TYPE OF EROSION IN THE CHENANGO VALLEY

By C. W. ROSE [1]

AN UNUSUAL type of erosion, which for the purpose of this discussion may be called flotation erosion, has been observed in lowlying areas or depressions in the Chenango River flood plains in Chenango County, N. Y. There is unquestionable evidence that from 4 to 6 inches of soil was removed, en masse, from some of these areas. The actual mechanics of its removal is a matter of conjecture. However, the circumstances prevailing at the time this erosion is known to have occurred, in the spring of 1936, strongly indicate that ice was the agent responsible for this heavy loss of soil.

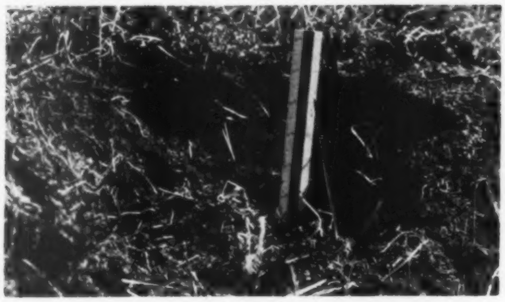
The soil of the river flats is a dark brown silt loam at the surface with a light brown clay subsoil, and resembles Eel silt loam or Middlebury silt loam. When these depressions are plowed the soil is found to be granular and to have a high content of organic matter. It becomes very porous down to plow depth, but below this depth it is quite impermeable.

It appears that water, standing in these depressions in the fall, permeates the soil that has been loosened by plowing and covers it to a depth of several inches. Then, during the winter months, the porous water-soaked surface soil and the water in the depression become frozen into one cohesive mass. Perhaps at later times, during winter and early spring, more water drains into the depression and freezes to the original ice-and-soil mass. When the spring freshet occurs, and the whole flood plain becomes submerged under several feet of slowly moving water, the mass of ice, with its burden of soil attached to the lower side of it, is buoyed up and floated downstream.

On the farm of Robert Westover near Oxford, N. Y., an area of approximately 2 acres occupying the lowest portion of a depression was almost completely denuded of its surface soil by this type of erosion during the spring of 1936. An additional 3 acres of this depressed area was very spotted, due to removal of surface soil in some places, and its retention in situ in others. Two smaller areas, most of which had sod or swamp grass cover, were similarly eroded; and eight parallel strips, about 2½ feet wide, where the owner had burned windrows of hay late in the summer were almost completely denuded of surface soil. It appears that the burning materially weakened the sod.

The boundaries of all the eroded areas were in general very well defined with vertical sidewalls indicating that the surface soil had been picked up vertically, instead of having been washed away by the running water.

[1] Junior soil conservationist, Northeastern Region, Soil Conservation Service, Machias, N. Y.



The six-inch scale, standing on the original meadow sod, shows at least five inches of transported soil with a good sod cover.

The evidence supporting the theory of flotation erosion is conclusive. It consists of layers of seemingly undisturbed, though transported, soil ranging in thickness from 4 to 6 inches and in diameter up to 50 feet or more, found scattered along the river flood plains to a maximum distance of 1,500 feet downstream from their original positions. These blocks of soil had definite boundaries and were covered with millet stalks and stubble and, in some cases, grass sod. The stubble and sod invariably were found in an upright position with no deposition over them.

The largest eroded area is too wet normally for cultivation until midsummer, and for several years, including 1935, it had been cropped with millet. The owner, when he harvested millet in the fall of 1935, was unable to mow the northeast corner of the area because of excessive water. A distinct line of demarcation then existed, with millet stalks standing on one side and millet stubble on the other. After the 1936 spring freshet, a block of soil 50 feet in diameter with this same line of demaraction was found on a meadow about 700 feet downstream from its original position. Neither the millet stalks nor stubble appeared to have been disturbed. This recently deposited soil was removed in several places, and it was found to average about 5 inches in thickness. No difficulty was encountered in making this determination, as the meadow sod under the deposit was easily detected.

Blocks of superimposed soil were found scattered over the river flats for a distance of approximately 1,500 feet to a point where Bowman Creek enters the river from the north. Any blocks of ice and soil which reached this point probably were deflected into the main river channel by the faster moving water of the creek. No blocks were found below this stream.

Since flotation erosion is known to have occurred in several depressions in the flood plains of the Chenango River in 1936, it is reasonable to assume that it has happened many times in the past, and that under favorable weather conditions it may continue to occur in the future, not only along the Chenango River, but along many of the larger streams of the country when and where favorable climatic and soil conditions prevail.

First bottom soils, it would seem, may provide ideal conditions for the occurrence of flotation erosion, and it is not improbable that many flood-plain depressions have been formed or accentuated by repeated occurrences of the phenomenon.

ECONOMIC AND SOCIAL CONSIDERATIONS

(Continued from p. 287)

is pursued with the farmer, he should realize the validity of the new farm plan and proceed to put it into execution without mental reservation as to its desirability.

When the organization or combination of enterprises, land use, and practices that is considered best by both the technician and the farmer is arrived at, the program of conservation operations and the land-use map, setting forth the land use and practices as agreed upon, should be prepared

It is believed that the general procedure outlined herein has considerable merit. Through this method of procedure, both the farmer and the planning technician obtain a clear-cut inventory of the farm, and they are able to look at the farm from the same viewpoint. This method of approach should aid in speeding up the planning process, since the farmer is not placed on the defensive in attempting to safeguard his immediate income. Both the farmer and the farm planner are primarily interested in the best continuous utilization of the farmer's resources. Since the farmer assisted in formulating the plan and considered the alternative organizations suggested, as well as the organization that was finally adopted, he should realize both the physical and economic soundness of the plan, and should proceed without mental reservation in putting this plan into effect. It is believed, therefore, that such consideration will speed up the planning process and result in "sounder" plans, will reduce the time ordinarily required in assisting and encouraging the farmer in performance, and finally, will assure more effective application of the plan by the farmer.

FARM LABOR IN A SOIL CONSERVATION PROGRAM

By S. W. ATKINS [1]

SOIL and water conservation programs will affect farm labor chiefly as a result of shifts in crop and livestock systems and changes in structural control. For instance, the total amount of labor used and its distribution throughout the year will be affected by changes in acreage and/or the kind of crop. Any decrease in intensity of the cropping system will tend to decrease the total amount of labor. On the other hand, the amount of labor used will increase in certain circumstances because of maintenance labor required on such facilities as terraces, meadow strips, grassed waterways and pastures. Furthermore, the time used to perform certain field operations per acre of land will change as a result of changes in size and shape of fields through terracing and strip cropping and of such practices as contour tillage.

A study [2] in progress since January 1, 1937, in the Cedar Creek soil conservation demonstration project area, Franklin County, N. C., has been designed to determine in part the impact of the planned program of soil and water conservation on farm labor. This study is based on information obtained from daily labor records kept by farmers, from opinions of farmers, and from certain observations made in the field by research workers.

Changes in the cropping systems on farms under agreement with the Soil Conservation Service have not resulted in any significant change in the total amount of farm labor used on the representative farms studied. On 18 identical farms the estimated increase in the total amount of labor resulting from changes in number of acres in the various crops was slightly less than 10 percent, or a total of 42 man work units, during the first 3 years of the Soil Conservation Service program (table 1).

TABLE 1.—*Man work units [1] per farm used in crop production on 18 identical farms before and after inauguration of the Soil Conservation Service program*

Crop	Man work units		
	Before (1935)	After (1938)	Change
Row crops:	*Units*	*Units*	*Units*
Corn	144	121	−23
Cotton	100	85	−15
Tobacco	177	256	79
All row crops	421	462	41
Small grain	4	2	−2
Hay	16	16	(2)
Cover crops for soil improvement	5	9	4
Seed	5	4	−1
Total [3]	451	493	42

[1] 1 unit equivalent to amount of work accomplished by an average farmer in this area in 10 hours.
[2] Less than 0.5 units.
[3] Normal work units per acre were used in calculating the total labor used.

This net increase was caused by a shift of some cropland from cotton production to tobacco, a crop which uses considerably more labor per acre. This shift resulted chiefly from an increasing price advantage for tobacco rather than from the planned soil and water conservation program. Changes in the amount of labor used on other crops, such as corn, hay, seed, and crops for soil improvement, also resulted principally from changes in number of acres and kinds of crops.

An analysis of these changes shows that the small increases in quantity of labor used on cover crops for soil improvement were almost entirely offset by corresponding decreases in labor on small grain harvested and on seed crops. Labor on seed crops declined, notwithstanding the increase in number of acres. This decrease in labor was a result of a shift from the production of cowpeas for seed to lespedeza for seed; lespedeza requires relatively small quantities of labor per acre. For like reason the shift from cowpea hay to lespedeza and meadow-strip (grassed-waterway) hay resulted in no significant increase in total amount of labor used, although the acreage of hay was expanded.

Case studies of proposed conservation programs on farms representing the two major types of farming in this area indicate that slightly less labor will be used under the proposed plan than was used under the original plan (table 2). This is assuming, of course, that the conservation programs are carried out as planned. Insofar as crops are concerned on these case farms, reductions in the amount of labor will result principally from a shift to crops having relatively low

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[2] Cooperative with the North Carolina Agricultural Experiment Station, the Soil Conservation Service, and the Bureau of Agricultural Economics.

labor demands per acre, and from a small reduction in acreages of corn and cotton. The combined reductions in the amount of labor used are offset only in part by increases in the amount used for small grain and for cover crops. Changes in labor used on livestock are not likely to be significant in the area, according to indications on these case farms which are fairly typical of the area in this respect. Expected increases in labor used on pasture maintenance will be offset in part by reduction in chore labor because of greater convenience, for the most part, in handling newly established permanent pastures.

TABLE 2.—*Man work units ued on 2 representative farms under original and proposed farm plans*

Item	Tobacco-cotton farm		Cotton farm	
	Original	Proposed (S. C. S.)	Original	Proposed (S. C. S.)
	Units	*Units*	*Units*	*Units*
Row crops	427	413	108	99
Grain [1]	2	17	0	0
Hay	14	8	4	5
Cover crops for soil improvement	4	[2] 1	0	6
Seed	25	[2] 15	9	0
All crops	472	454	121	110
Pasture maintenance	0	2	0	1
Livestock	50	57	27	27
Total	522	513	148	138

[1] Grain harvested with combine.
[2] Labor on lespedeza was included only in the seed crop group, although this crop is also used as a soil-improving crop after the seed is harvested.

Maintenance of structural erosion-control facilities under the Soil Conservation Service program will result in little, if any, change in amount of farm labor used on the average farm.[3] Farmers' opinions indicate that the amount used on maintenance of terraces increased on about one-third of all farms reporting and decreased on other farms reporting (table 3). A much smaller proportion—about one-eighth—reported increases in the amount of labor used in maintenance of terrace outlets, including meadow strips or grassed waterways.

TABLE 3.—*Farms reporting specified changes in amount of man labor used for terrace and terrace-outlet maintenance as a result of the Soil Conservation Service program*

Item	Number and percent of farms			
	Terraces		Terrace outlets	
	Number	Percent	Number	Percent
All farms reporting	44	100	42	100
Farms reporting increase	16	36	5	12
Farms reporting decrease	28	64	36	86
Farms reporting no change	0	0	1	2

These opinions are corroborated by observations of research workers and by related data. For example, terracing was practiced on approximately 90 percent of the farms in the area prior to the establishment of the Soil Conservation Service program. According to reports from cooperating farmers, their old terraces were damaged much more frequently by heavy rains than were terraces constructed by or under the supervision of the Soil Conservation Service. These old terraces actually use more maintenance labor, in terms of repair work on breaks than do terraces of approved specifications. Furthermore, on meadow strips little or no maintenance labor is used other than that chargeable directly to the hay crops commonly harvested from these strips.

Cooperating farmers generally believe that such Soil Conservation Service practices as terracing, contour tillage, and strip cropping have not materially increased the amount of labor used per acre of land. Of 47 farmers reporting, more than 90 percent expressed the opinion that the labor used per acre had not changed for such operations as breaking, harrowing, cultivating, and mowing. Data on farm labor, collected from daily labor records, show little difference in amount of labor used per acre on important field operations on cooperating and noncooperating farms (table 4). Only in cultivation was there a noticeable difference between the two groups in amount of labor used per acre. The few operators who reported a larger amount of labor used per acre thought that shorter rows was the major causal factor. It is probable that this factor was responsible, in part, for the higher average hours per acre used in cultivation, as shown in table 4. Because of the greater number of times the operation was performed, any increase in labor per acre would tend to be greater than on operations requiring less frequency of performance, such as running rows and distributing fertilizer.

That the program of the Service has had little effect on labor used per acre is to be expected. On a large proportion of farms, small irregularly shaped fields predominated prior to initiation of the program, and they were not changed greatly by the terracing and

[3] It is recognized that labor used in establishing structural erosion-control facilities often involves relatively large quantities of labor and power. Since this type of work on demonstration farms was done in part by the Soil Conservation Service, the burden on farm labor resources was greatly relieved. Without this assistance the accomplishments on many farms necessarily would have been distributed over a longer period of time.

TABLE 4.—*Hours of man labor per acre reported by 14 cooperating and 25 noncooperating farms, 1937, in performing specified operations on corn, cotton, and tobacco* [1]

Operation	Cooperating farms	Noncooperating farms
	Man labor hours	*Man labor hours*
Flat breaking, 1-horse	10.0	10.0
Flat breaking, 2-horse	7.0	7.2
Bedding, 1-horse	6.9	7.1
Running rows, 1-horse	1.8	1.9
Distributing fertilizer, 1 horse	2.1	2.0
Listing, 1-horse	3.9	3.8
Planting, 1-horse [2]	2.0	2.0
Cultivating, 1-horse	17.5	16.2

[1] Averages for each crop were analyzed separately by operations. Differences between crops, for purpose of comparing cooperating and noncooperating farms, were not significant.
[2] Cotton and corn only.

strip cropping recommended. Research data, collected in this area, indicate however that an increase in amount of labor used per acre will likely occur on farms on which the conservation program has caused a decrease in size of fields and/or made fields more irregular in shape.

Distribution of labor throughout the year on farms in this area is generally characterized by high peak demands during certain periods and by very low demands during others. On tobacco farms these peak labor loads normally occur during planting, harvesting, and grading seasons. On cotton farms peak loads occur normally during cultivating and picking seasons. On both types of farms there are periods when the available labor resources normally are not utilized productively, while during other periods labor demands exceed the normal available labor supply. Deficits in normal labor available at peak labor loads are commonly supplied by exchange labor, by labor of women and children, and by working longer hours.

Planned cropping systems inaugurated on farms under agreement with the Soil Conservation Service will tend to improve labor distributions on both tobacco and cotton farms in this area. A comparison of labor distributions on a tobacco and cotton farm prior to and under the Service program shows that the proposed cropping systems tend to decrease the former peak loads and to increase the amount of labor used during the previous low points in the labor distribution. Peak loads are reduced under proposed plans partly as a result of a decrease in cotton acreage and further as a result of shifts from cowpea and soybean hay to lespedeza hay. Not only is it true that lespedeza demands less labor per acre, but it is also true that the labor used in preparation and seeding in early spring does not conflict so seriously with other farm labor as does labor used on cowpeas and soybeans. Terraces and other structural maintenance practices are also using available labor during slack periods. Fall seeding of winter cover crops and fertilizing of pastures, meadow strips, and small grain in early spring, are also being done on these farms during periods of normally low labor use. However, some resistance to seeding early fall crops exists, because of possible conflict with grading tobacco and picking cotton. These crops frequently are rushed to market to supply badly needed operating capital, but many farmers are readjusting their operations to allow for time necessary to make fall seedings without seriously delaying fall harvesting and marketing operations. Apparently, these readjustments will be made on an increasing number of farms as farmers learn to "live with" the new program.

The changes in labor resulting from planned programs of the Soil Conservation Service have not been marked to date, nor will they likely be reflected in significant increases in cash expenses for labor, as far as this area is concerned. Only about one-tenth of all farm labor is represented by wage labor and even some wage laborers are paid in part with a share of the crop. Nine-tenths of the labor is performed by operators, operators' families, and sharecroppers. Exchange labor is common during peak labor loads and is usually performed by operators and their families. Under present share-crop contracts, croppers absorb any increase in the amount of labor used per acre of land caused by terracing, strip cropping, and contour tillage. Some farmers hire extra labor—often their sharecroppers—to seed winter cover crops. On the majority of farms, however, labor involved in production of extra crops and such maintenance work as is done on terraces, pastures, and terrace outlets can be done by the regular labor supply with little or no cash outlay for labor. This is made possible chiefly by the distribution of the extra labor which does not seriously conflict with the regular labor. On most farms a surplus of regular labor, which has few or no productive alternative opportunities, is available in slack periods. Based on the above, the "additional labor bugaboo" cannot offer any hindrance to the initiation and operation of a definitely planned program of soil and water conservation on farms in this area.

The Soil Conservation Service has announced that 8,500,000 acres of land in 141 land utilization projects established since 1933 will be opened for free public use for hunting, fishing, and trapping.

ORCHARD DISK ESPECIALLY SUITED TO CONTOUR PLANTING

By HENRY CLAY LINT[1]

PEACH orchards in the Coastal Plain section of New Jersey are generally clean tilled during the summer months. The practice most frequently recommended consists of seeding the orchard to a vetch and crimson clover mixture about the middle of August. Such a cover is allowed to remain until late April or even late May, depending on the amount of moisture in the soil.

Under some soil conditions, the planting of alternate middles to perennial leguminous cover has worked out satisfactorily in peach orchards, but clean cultivation during the summer is standard practice and the evidence and experience indicate that it is likely to continue. Terracing and contour cultivation therefore naturally suggest themselves as a means to erosion control during this period of the year when there is no cover in the orchard.

In starting a new peach orchard, it is imperative that the young trees be clean cultivated, and one of the objections to contour planting is that the one-way cultivation necessitates hand work in eradicating weeds between trees in the rows. A strip of mulch about 5 feet wide has been used for this purpose, with varying degrees of success. Some plantings will come through with a minimum of weed growth, but others under different conditions show that no practical amount of mulch is effective in inhibiting weeds.

A solution to the problem of weed elimination in the tree row between trees appears to have been found through the use of an implement known locally as a grape-hoe. It is simply a V-type cultivator which has hinged behind it a straight coulter equipped with a single handle with which the operator steers the cultivator much as he would manipulate the tiller on a boat. By attaching the grape-hoe to the extreme end of a disk harrow, the operator is able to cultivate the space in the tree row between trees, and by using the steering lever he is able to miss the trees. With this implement it is possible to cultivate out practically all weeds.

The disk, developed by Messrs. Nocenti, Hubbard, and Granholm of the Moorestown staff, is an adaptation of the old extension cultivator developed as long ago as 1913 in New Jersey by Prof. A. M. Blake. It is an effective cultivator, capable not only of maintaining but also in the upbuilding of tree-row berms. Our experience with starting a new orchard on our light sandy soils indicates that the berms should be built up as the tree roots spread out, and that best growth is most likely where the trees are planted with backfurrows to aid in bringing the moisture supply near to the tree roots.

The ordinary farm disk as it is used in orchards is not effective in building up a berm on the tree row; in fact backfurrows or even small terraces are likely to be destroyed by the ordinary disk. It was to overcome these difficulties that an Oliver orchard disk was reconstructed so that in its operation all movement of the soil would be from the center of the tree middle toward the tree; with both gangs set to throw out, they merely were spaced 5 feet apart. To understand its operation, imagine tree rows 20 feet apart and assume that the space is to be divided into 4 strips, A, B, C, and D, each 5 feet wide. On one trip through the orchard, strips A and C are cultivated; on the next trip, areas B and D are covered. In actual practice, contour rows are not everywhere parallel so that it may be necessary sometimes to go down the tree middles with an ordinary disk to cultivate out some small islands left by this orchard disk.

The effectiveness of the new-type orchard disk is indicated by comparison with an ordinary farm disk and plow in the following table:

Terrace number	Percent slope of land above terrace	Terrace channel cross section			
		May 17	June 18	July 18	August 15
	Percent	*Sq. feet*	*Sq. feet*	*Sq. feet*	*Sq. feet*
1	6.20	2.79	.58	2.05	4.04
2	8.06	3.94	.34	1.51	2.62
3	6.53	4.29	.54	3.37	5.91
4	5.44	2.91	.83	2.54	5.91
5	4.67	5.50	.88	3.85	8.67
6	1.37	13.46	1.39	3.68	10.98

May 17. Backfurrow only 2 rounds with 14-inch plow.
June 18. After 3 cultivations with ordinary farm disk.
July 18. After 2 cultivations with orchard disk.
August 15. After 6 cultivations with orchard disk.

The orchard was planted in the spring of 1938 and backfurrows were thrown up at that time. In the fall

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Type of "grape-hoe" used in contour orchard cultivation.

of 1938, the terrace outlets were seeded. To prevent concentration of water in the outlet, the backfurrows were deliberately knocked down when the winter cover was seeded. New backfurrows were thrown up in the tree rows about May 1, 1939, but the stand of vetch and crimson clover was left intact between the plowed areas until about May 15, when it was disked to kill the cover crop. A series of elevation readings was made over 6 rows just before the first disking and permanent bench marks were installed as it was expected that the development of these terraces would be studied over several years as the thesis of an evaluation survey.

The cross-section data of May 17 therefore represent the terrace channel capacities resulting from the backfurrows alone. During the following month, the grower cultivated three times on the contour with an ordinary four-gang disk, and how thoroughly the backfurrows were torn down is shown by the relative capacities on June 18. Between June 18 and July 18, the farmer cultivated twice with the orchard disk, and the cross section on the latter date shows to what extent the disk was successful in again building up the berms. Between July 18 and August 15 four additional cultivations were made, so that the final capacities shown are the result of six diskings.

In securing the data for the cross sections, an instrument was developed which enables obtaining elevations to 0.01 foot at horizontal intervals of 0.1 foot very quickly. A straight piece of lumber 2 inches by 3 inches by 12 feet is marked at 0.1 intervals. Supports are provided to maintain this instrument level with the ground surface when measurements are taken in the field. A carriage slides along the straight piece of lumber and a weight suspended by a string is dropped until it just touches the soil. The other end of the string is tied to a sliding scale and the readings can be made direct. It will be understood, of course, that the high point of a berm may consist of far too little soil to enable the berms actually to hold as much water as the cross-section area would indicate. All measurements were made over exactly the same course, in a straight line between the top and bottom bench marks. It so happens that the line selected is at a fairly sharp curve in the terrace berms. It was observed that the disk was even more effective on the straightaway portions of the berms than at the place where the cross-section data were taken.

A study of the cross section shows that the increased capacity is due to a lowering of the channel or space in the tree middle rather than to raising the height of the berm. The latest cross-section measurements indicate the development of a true terrace with the low point of the channel 7 to 12 feet above the berm instead of about 3 feet as was the case with only backfurrows.

While the results obtained by using this type of disk are all that could be desired, the implement has one serious fault in that all of the end thrust is borne by the bearing boxes, thus causing both boxes and the spacer spools to wear fairly rapidly. Several ways of overcoming this difficulty have suggested themselves and once this is worked out there should be little difficulty in convincing farmers of the importance of converting their own disks along these lines. The only new materials required for changing present types of farm disks to this new one are two angle irons 3½ inches by 3½ inches by ⅜ inch.

Pasture Treatment in the Ohio Valley

On the Leatherwood Creek project near Bedford, Ind., farm records secured by Marion M. Merritt and J. M. Rudy show that several farm pastures treated with 1½ and 2 tons of lime and 400 pounds of superphosphate (20 percent) per acre, produced about twice as much forage as similar pasture land that was not treated. Records were kept on 6 farms in 1938 and on 12 farms in 1939. The increased returns nearly paid for the lime and fertilizer the first year. Another application will not be needed for 3 to 5 years. Such treatment of poor pastures is justified also because it makes possible a thicker cover of vegetation to reduce soil losses and run-off, provides a more nutritious feed, and encourages farmers to keep more of their land in grass. More details of this are reported in Regional Circular 188, Dayton, Ohio, April 25, 1940.—A. T. Semple.

A MODIFIED MOWER FOR LEAVING HIGH STUBBLE

By HUGH G. PORTERFIELD [1]

ON much of the severely eroded cultivated land and the denuded ranges in the Dust Bowl the establishment of cover crops is necessary to prevent further erosion and to furnish protection for the grass seedlings in their first growth periods. In the beginning stages of the revegetation program in this area it was apparent that a mower was needed that would (1) cut stubble covers from ground level to at least 16 inches in height, and (2) mow weeds and sorghum covers on listed fields on which the ridges were not worked down. Such mowing operations would permit the testing of the erosion resistance of covers cut at various heights in preparation for grass seedings, and also the effect of different heights of stubble in obtaining and maintaining grass stands when residue is allowed to remain on the ground. A mower that would meet all the needs for experimental or field work was not available at the beginning of the revegetation program. Most of the regular stock mowers will cut only up to approximately 8 inches in height, and they will not operate satisfactorily over lister ridges.

A mower having a wide range of uses in cutting various cover crops has been developed on the Dalhart research project. One of the chief values of this machine is that it has a cutting range varying from ground level to 16 inches in height. It has proved satisfactory for mowing weeds on deep-listed land as well as sorghums planted with a lister and allowed to mature without cultivation.

The following changes or adjustments were made:

1. The "lifting chain eye bolt" of the usual mower is made of high carbon steel and often breaks from vibration and "whip" of the cutter bar when mowing over 6 inches in height. This piece of high carbon steel is replaced on the modified machine by a piece of malleable iron rod at a cost of 30 cents, and thus the abovementioned defect is eliminated.

2. The tractor hitch should be approximatey 2 feet from the ground and this necessitates that it be raised or that a supplemental hitch be used. This modification adds height to the front of the mower and keeps the protective case and shoe for the pitman from dragging in lister ridges.

The modified mower cutting standard broomcorn cover approximately 16 inches high, in preparation for spring grass seeding. Observe the height at which the mower is hitched on to the tractor. Amarillo Experiment Station, Sand Dune Stabilization and Revegetation Sub-Project, Dalhart, Tex.

3. The mower tongue is shortened approximately 18 inches and the spring release hitch is discarded to make a solid strap-type hitch on the mower tongue. This is an aid in obtaining height for the front of the mower.

4. The cutter bar is reset for level and tilt. Until after the first few settings, this is mostly a matter of trial-and-error adjustment.

It seems apparent after inspecting several different makes of mowers that any of them could be adapted to the work with practically these same changes. The modified mower, cutting at a height of 16 inches, may be pulled at the regular speed behind a tractor without damage. In crossing road ruts and other extremely rough places it is advisable that the cutter bar be raised to an upright position.

NOTE.—Acknowledgement is made to B. F. Barnes, United States Dry Land Field Station at Dalhart, Tex., and to Charles J. Whitfield, Soil Conservation Service, Amarillo Tex., for suggestions in this work.

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More and more, farmers are learning that systematic maintenance work is essential for satisfactory functioning of terraces. Soil Conservation Service projects continue to emphasize the need for this work and to demonstrate proper methods.

BOOK REVIEWS AND ABSTRACTS

by Phoebe O'Neall Faris

TERRACE OUTLETS AND FARM DRAINAGEWAYS. By C. L. Hamilton. U. S. Department of Agriculture Farmers' Bulletin No. 1814. 1939.

This publication has been in use for some months. However, for the benefit of those not yet acquainted with the newest and best available information on the construction, use and maintenance of surface run-off disposal measures required in upland or rolling terrain, it is reviewed here with special attention to details. The bulletin is a logical follow-up of Mr. Hamilton's earlier work on terracing for soil and water conservation, published in May 1938. "Terrace Outlets and Farm Drainage-ways" is a constructive piece of work; it goes directly into what to do and how to do it, for maintenance of effective run-off control on sloping farm land.

In the beginning the author points out that one or more soil-conservation practices, such as crop rotations, plant cover, strip cropping, contour tillage, diversion ditches, and terracing, will provide adequate protection to farm land if outlets and drainageways are properly constructed and protected. Stabilized drainageways are necessary, and natural depressions protected by the original vegetation are emphasized as most important in surface-drainage systems. But so many natural drainageway systems no longer function for safe and effective disposal of excess run-off—and hence this bulletin describing tried and approved treatments for drainageways on terraced and unterraced farm land.

Planning the run-off disposal system comes first in establishing soil-conservation measures, according to the author, whether the area is terraced or unterraced. "Many * * * individual drainageways that result from haphazard planning cannot be utilized efficiently when additional conservation measures are established, and they may even hinder the use of subsequent conservation practices." The planning of a drainage system according to the drainage unit is described as a careful observational study of a farm with special attention to surrounding fields and topographical features such as depressions, laterals, ridges and slopes, and with special consideration for proposed or existing soil-conservation practices. Unterraced areas are discussed with regard to grassed drainageways in natural depressions where land is used for crops, areas of rolling relief and branching watersheds, and land being retired to permanent cover.

"The cost of terrace construction and the success of the terraces are dependent upon the proper planning of outlets." Hence, the greater part of this bulletin is devoted to the planning and construction of economical and practical outlets for proper disposal of run-off from terraced areas. For the purpose of planning, outlets are classified as follows: (1) Grassed or wooded individual outlets; (2) meadow or pasture strips; (3) grassed channels; (4) channels protected by mechanical structures. In a detailed discussion of outlet types, the author points out various conditions which must be thoroughly considered in making preliminary plans, such as topographic features, size of fields, the grade and stability of natural drainageways below the outlets, local rainfall intensities and distribution.

For determining the hydraulic principles necessary for the design and construction of outlet channels, three tables are here shown which greatly simplify computations. Table 2 gives maximum run-off to be expected once in 10 years from drainage areas of 1 to 300 acres on rolling and hilly timber land, rolling and hilly pasture, rolling and hilly cultivated land, and rolling cultivated terraced land. Table 3 gives approximate dimensions of outlet channels with grass covers capable of resisting maximum average channel velocities of 5, 6, or 7 feet per second, with 4:1 side slopes and with good channel conditions. Table 4 shows the approximate discharge capacity of rectangular notches in small check dams. These tables are said by the author to be sufficiently accurate for all practical purposes.

The latter part of the bulletin is given over to the grading of drainageways, the alinement of terraces and outlets, methods of establishing vegetative cover in outlet channels or drainageways, and construction of mechanically protected outlets. It is pointed out that a satisfactory water-disposal system on the farm or watershed requires considerable attention not only in its planning and construction but in its maintenance. Frequent inspection and repair are emphasized as necessary to prevent cutting, silting, or damage to vegetation or structures.

THE MANAGEMENT OF FARM WOODLANDS. By Cedric H. Guise. New York, 1939.

Some of the workers in the Service and many cooperating farmers may not have discovered this book, although it made its first appearance some 5 months ago. The volume is good reading as well as an excellent beginning text on the management of small and large farm woodlands for maximum advantage and protection. Farmers will be especially interested, as the author has used a somewhat new approach in treating woodland problems—he has given life to his tree communities by presenting early in the volume a chapter on the physiology of trees, and another, immediately following, on the ecology of farm woodlands. In this part of the book in particular, and to some extent throughout, Mr. Guise displays an unusual talent for integrating the scientific and technological knowledge of woodlands with the social and economic requirements.

Some 80 pages are devoted to methods of estimating and calculating volumes, yields, and growth values of trees and woodland stands. The Doyle, Scribner, and the International log-rule tables are explained and compared, and formulas are given for making deductions for defects, for obtaining tree diameters, heights, wood content, and increment percentages. The surveying and mapping of larger woodland properties is included in this section of the book.

The latter half of the text consists of a description of the approved silvicultural practices for improving, planting, protecting, and

BOOK REVIEWS AND ABSTRACTS continued

utilizing tree stands whether small farm woods or tree plantations. In a chapter on care and improvement of woodlands, timber cutting for thinning or pruning is treated with considerable attention to detail, and another chapter dealing with farm-woodland protection explains quite thoroughly the best means of minimizing damage to stands through grazing, fires, insect and fungus pests, and tree diseases. Logging and seasoning of lumber are treated briefly, but a detailed chapter on wood preservatives makes this part of the book particularly useful to farmers who have stands of the less durable woods that could be used for farm-building construction, posts, etc., if properly treated against decay-producing forces.

The last chapter consists of a very lucid discussion of a workable farm-woodland management plan designed to protect the forest and the forest soil by proper cutting and planting practices, and to maintain a steady net income in return for labor and ingenuity and actual cost expended in a systematized plan carried out in detail. The book is well illustrated and contains many tables and charts of actual use in managing farm woods. Although examples pertain chiefly to woodlands of the eastern part of the United States, the principles of management are such that they can be applied throughout the country with details varying in different geographic and ecological sections. A list of selected references is included for those desiring more detailed knowledge on specific phases of forest and farm-woodland management problems.

THE "WHEELS" OF EROSION

(Continued from p. 289)

they do come to rest they play, with remarkable fidelity, the roles of pebbles, cobbles, or boulders in a place where genuine cobbles are infrequent and true boulders quite unknown.

It is natural for the soil conservationist to ask what can be done about this type of transportation. Field observations indicate that mud balls are always large in relation to the average size of the particles which form the stable bed of the stream in which they are formed, and that balls more than a foot in diameter are quite rare. If the balls investigated are typical, these large specimens may be counted on to break if they are dropped 8 inches, and those which are 8 inches in diameter will break when dropped 1 foot. A ball 4 inches in diameter will break if dropped 4 feet, and a 16-foot drop will ensure the destruction of a 2-inch ball. Apparently if the diameter is halved, the drop must be multiplied by four.

It would seem, then, that almost any drop such as occurs at a soil-saving dam may be expected to break all the larger balls, and the fragments can be prevented from re-forming into smaller balls if the channel bottom is artificially roughened downstream. In channels where no drop structures are present or contemplated, much could be accomplished by providing obstacles downstream from the chief clay sources so that incipient balls might be broken through impact. Two advantages are gained by reducing the size of the clay masses: (1) The fragments encounter only those lower velocities which prevail close to the streambed, thus the rate of transportation is slowed down, and (2) the mean size of the pebbles which may be carried away is reduced. In addition, the normal channel roughness becomes proportionally greater and is more effective in preventing the smaller clay chunks from rolling freely. This hinders the development of the high sphericity which is essential for the most efficient transportation of bedload materials.

CREDIT RATINGS

(Continued from p. 298)

All the Federal agricultural agencies are working to help conserve basic farm assets and to add to farm security. Farm Credit does this by saving the farmer on his interest costs. Other agencies help to save soil assets—to keep them from being washed or blown away. The individual farmer who is trying to save money by obtaining farm credit at a low cost, and also trying to conserve his primary investment, his soil, is making use of both types of public services.

The new hydraulic laboratory of the University of Minnesota will be used for investigating erosion-control structural designs in accordance with recent arrangements for cooperative research work between the Service and the University. This is one of the largest hydraulic laboratories in the world, with a 50-foot maximum head of water and housing a 200-foot flume 6 feet deep and 9 feet wide with a capacity of 300 cubic feet per second.

U. S. GOVERNMENT PRINTING OFFICE: 1940